

WHAT IS CLAIMED IS:

- 1 1. A method for determining a germanium concentration of a
2 silicon germanium film, said method comprising the steps of:
3 performing a thermal oxidation procedure on said silicon
4 germanium film to create a layer of thermal oxide over said silicon
5 germanium film;
6 measuring a thickness of said layer of thermal oxide;
7 providing a correlation that relates a thickness of a layer of
8 thermal oxide created over a silicon germanium film to a germanium
9 concentration of said silicon germanium film;
10 determining said germanium concentration of said silicon
11 germanium film by identifying a germanium concentration that
12 corresponds to said measured thickness of said layer of thermal
13 oxide in accordance with said correlation.
- 1 2. The method as set forth in Claim 1 wherein said step of
2 measuring a thickness of said layer of thermal oxide comprises
3 measuring said thickness of said layer of thermal oxide in real
4 time using one of: an interferometer, an ellipsometer, and a
5 spectroscopic ellipsometer.

1 3. The method as set forth in Claim 2 further comprising the
2 step of:

3 performing in real time said step of determining said
4 germanium concentration of said silicon germanium film by
5 identifying a germanium concentration that corresponds to said
6 measured thickness of said layer of thermal oxide in accordance
7 with said correlation.

1 4. The method as set forth in Claim 1 wherein said
2 correlation that relates a thickness of a layer of thermal oxide
3 created over a silicon germanium film to a germanium concentration
4 of said silicon germanium film is an approximately linear
5 correlation.

1 5. The method as set forth in Claim 4 wherein said
2 approximately linear correlation is described by:

3 Oxide Thickness (Å) = 45.55035 + 2.2670656 Ge%

4 where said term Oxide Thickness is in units of Ångstroms; and

5 where said term Ge% represents a germanium concentration in a
6 silicon germanium film in terms of germanium percentage.

1 6. The method as set forth in Claim 4 wherein said
2 approximately linear correlation is described by:

3
$$\text{Relative Oxidation Rate} = 0.9795774 + 0.0487541 \text{ Ge\%}$$

4 where said term Relative Oxidation Rate represents a ratio of
5 a thickness of thermal oxide on a silicon germanium film to a
6 thickness of thermal oxide on a silicon wafer without a silicon
7 germanium film; and

8 where said term Ge% represents a germanium concentration in a
9 silicon germanium film in terms of germanium percentage.

1 7. The method as set forth in Claim 4 wherein said
2 approximately linear correlation is described by:

3
$$\text{Ge\%} = -20.03043 + 20.470103 \text{ Relative Oxidation Rate}$$

4 where said term Relative Oxidation Rate represents a ratio of
5 a thickness of thermal oxide on a silicon germanium film to a
6 thickness of thermal oxide on a silicon wafer without a silicon
7 germanium film; and

8 where said term Ge% represents a germanium concentration in a
9 silicon germanium film in terms of germanium percentage.

1 8. The method as set forth in Claim 2 further comprising the
2 step of:

3 measuring said thickness of said layer of thermal oxide in
4 real time by making a plurality of thickness measurements of said
5 thickness of said layer of thermal oxide in real time using
6 one of: an interferometer, an ellipsometer, and a spectroscopic
7 ellipsometer.

1 9. A method for determining a correlation between a
2 germanium concentration of a silicon germanium film and a
3 thickness of a layer of thermal oxide created over said
4 silicon germanium film, said method comprising the steps of:

5 creating a plurality of silicon germanium films in which each
6 silicon germanium film has a different germanium concentration;

7 creating a layer of thermal oxide over each of said plurality
8 of silicon germanium films;

9 measuring a thickness of each of said layers of thermal
10 oxide; and

11 correlating said thickness of each of said layers of thermal
12 oxide with a corresponding value of germanium concentration.

1 10. The method as set forth in Claim 9 wherein said
2 correlation between a germanium concentration of a silicon
3 germanium film and a thickness of a layer of thermal oxide created
4 over said silicon germanium film is an approximately linear
5 correlation.

1 11. The method as set forth in Claim 10 wherein said
2 approximately linear correlation is described by:

3
$$\text{Oxide Thickness (\AA)} = 45.55035 + 2.2670656 \text{ Ge\%}$$

4 where the oxide thickness is in units of Angstroms and the
5 term Ge% represents a germanium concentration in a silicon
6 germanium film in terms of germanium percentage.

1 12. The method as set forth in Claim 10 wherein said
2 approximately linear correlation is described by:

3
$$\text{Relative Oxidation Rate} = 0.9795774 + 0.0487541 \text{ Ge\%}$$

4 where said term Relative Oxidation Rate represents a ratio of
5 a thickness of thermal oxide on a silicon germanium film to a
6 thickness of thermal oxide on a silicon wafer without a silicon
7 germanium film; and

8 where said term Ge% represents a germanium concentration in a
9 silicon germanium film in terms of germanium percentage.

1 13. The method as set forth in Claim 4 wherein said
2 approximately linear correlation is described by:

3
$$\text{Ge\%} = -20.03043 + 20.470103 \text{ Relative Oxidation Rate}$$

4 where said term Relative Oxidation Rate represents a ratio of
5 a thickness of thermal oxide on a silicon germanium film to a
6 thickness of thermal oxide on a silicon wafer without a silicon
7 germanium film; and

8 where said term Ge% represents a germanium concentration in a
9 silicon germanium film in terms of germanium percentage.

1 14. A method for determining a germanium concentration of a
2 silicon germanium film, said method comprising the steps of:

3 providing a silicon substrate layer;

4 depositing germanium on said silicon substrate layer to form a
5 silicon germanium film;

6 performing a thermal oxidation procedure on said silicon
7 germanium film to create a layer of thermal oxide over said silicon
8 germanium film;

9 measuring a thickness of said layer of thermal oxide in real
10 time;

11 providing a correlation that relates a thickness of a layer of
12 thermal oxide created over a silicon germanium film to a germanium
13 concentration of said silicon germanium film;

14 determining said germanium concentration of said silicon
15 germanium film in real time by identifying a germanium
16 concentration that corresponds to said measured thickness of said
17 layer of thermal oxide in accordance with said correlation.

1 15. The method as set forth in Claim 14 wherein said thermal
2 oxidation procedure is one of: a rapid thermal oxidation procedure
3 and a furnace oxidation procedure.

1 16. The method as set forth in Claim 14 wherein said step of
2 measuring a thickness of said layer of thermal oxide in real time
3 comprises measuring said thickness of said layer of thermal
4 oxide within a time period of approximately five minutes using
5 one of: an interferometer, an ellipsometer, and a spectroscopic
6 ellipsometer.

1 17. The method as set forth in Claim 14 wherein said step of
2 providing a correlation that relates a thickness of a layer of
3 thermal oxide created over a silicon germanium film to a germanium
4 concentration of said silicon germanium film comprises the step of:

5 providing an approximately linear correlation described by:

6 Oxide Thickness (\AA) = 45.55035 + 2.2670656 Ge%

7 where the oxide thickness is in units of Angstroms and the
8 term Ge% represents a germanium concentration in a silicon
9 germanium film in terms of germanium percentage.

18. The method as set forth in Claim 14 wherein said step of providing a correlation that relates a thickness of a layer of thermal oxide created over a silicon germanium film to a germanium concentration of said silicon germanium film comprises the step of:

providing an approximately linear correlation described by:

$$\text{Relative Oxidation Rate} = 0.9795774 + 0.0487541 \text{ Ge\%}$$

where said term Relative Oxidation Rate represents a ratio of a thickness of thermal oxide on a silicon germanium film to a thickness of thermal oxide on a silicon wafer without a silicon germanium film; and

where said term Ge% represents a germanium concentration in a silicon germanium film in terms of germanium percentage.

19. The method as set forth in Claim 14 wherein said step of providing a correlation that relates a thickness of a layer of thermal oxide created over a silicon germanium film to a germanium concentration of said silicon germanium film comprises the step of:

providing an approximately linear correlation described by:

$$\text{Ge\%} = -20.03043 + 20.470103 \text{ Relative Oxidation Rate}$$

where said term Relative Oxidation Rate represents a ratio of a thickness of thermal oxide on a silicon germanium film to a thickness of thermal oxide on a silicon wafer without a silicon germanium film; and

11 where said term Ge% represents a germanium concentration in a
12 silicon germanium film in terms of germanium percentage.

1 20. The method as set forth in Claim 14 wherein said step of
2 depositing germanium on said silicon substrate layer to form a
3 silicon germanium film comprises the step of:

4 exposing said silicon substrate layer to a gas comprising
5 silane gas and germane gas in a hydrogen gas carrier.